Spring 2006

Swoosh and Boom

QUARTERLY

Indian Head Division N S W C

CONTENTS

CONTENTS

Swoosh and Boom Quarterly

Cover: U. S. Marines assigned to the 7th Marines 3/4 Weapons Company run Nuclear, Biological, Chemical training with the Javelin Missile launch system. An IHDIV manufactured chemical, BTTN is used in the Javelin Missile (see article on page 3).

Swoosh and Boom Quarterly is published by the Naval Sea Systems Command, Indian Head Division, Naval Surface Warfare Center (IHDIV/NSWC). Articles and other contributions are welcome. IHDIV/NSWC reserves the right to make editorial changes. Views expressed are those of the authors and are not necessarily those of IHDIV/NSWC. All photos courtesy of IHDIV/NSWC unless otherwise credited. Distribution Statement A: Approved for public release; distribution is unlimited.

Captain Joseph Giaquinto
Commander, IHDIV/NSWC

Jerry LaCamera
Technical Operations Manager

Adam Nave
Business Director

Tara Landis
Public Affairs Office (Code PAO), Managing Editor
301-744-6504, tara.landis@navy.mil

Peggy Garlenski
Layout and Design (Code C42PG)
301-744-4294, margaret.garlenski@navy.mil

Johna Woods
Copy Editor (Code PA2)
301-744-6505, johna.woods@navy.mil

Indian Head Division
Naval Surface Warfare Center
"DoD Energetics Center"

Captain Joseph N. Giaquinto
Commander
Indian Head Division, NSWC

For over a century, the men and women of the Indian Head Division (IHDIV) have system-engineered energetic products and services for our warfighters, providing novel solutions and innovative technology to enable their pursuit in defending our nation and freedom around the world.

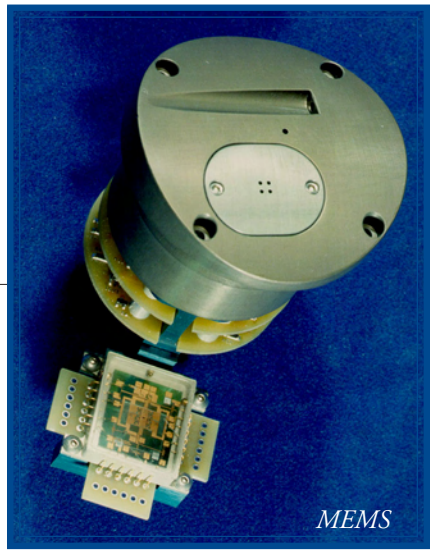
As a DOD Energetics Center, IHDIV is recognized as having the expertise and infrastructure to support the complete range of activity associated with Energetics. With this leadership position comes our responsibility to help sustain the Energetics technical competency, while bringing our nation and Armed Forces premier advanced technologies.

As the Global War on Terror continues, IHDIV's unique capabilities remain tremendously valued and in high demand. Our recent successes included bringing our nation thermobaric weapoins like the BLU-118B bomb, employed by the Air Force and highly successful in attacking enemy forces entrenched in caves during Operation Enduring Freedom (OEF), and the Shoulder Mounted Assault Weapon-Novel Explosive (SMAW-NE), providing the Marine Corps a powerful weapon adapted to combat the current threat and aiding Marines mission success during urban conflicts in Operation Iraqi Freedom. In addition, our national Energetics expertise is playing an increased role in countering Improvised Explosive Devices (IEDs)—a terror weapon used increasingly in the Middle East conflict.

Often referred to as "cradle-to-grave" or "full-spectrum" capability, IHDIV is an Energetics Center because we integrate at a single Energetic Materials designated location, the entire range of activities from research and development through test and evaluation of Energetic Materials and articles that contain them. Had scientists not been developing novel energetic formulations, like a thermobaric composition, 30 years ago, and had testing capabilities and expert scientists and engineers not been synergistically located at one location with formulation experts, IHDIV would never have been able to rapidly develop and provide the warfighter the BLU-118 or SMAW-NE. This rare and unique in-house capability of performing basic research at the molecular level, to producing and supporting warfighting products, is an invaluable asset to the Navy and the Nation.

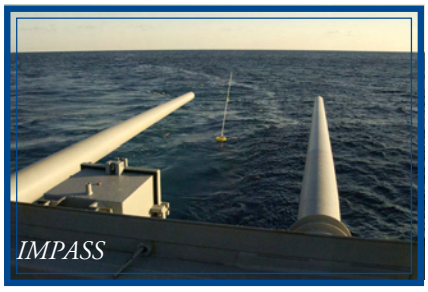
This Winter Edition of the *Swoosh and Boom* is a shining example of this cradle-to-grave capability and the broad spectrum of products and processes that we touch. In this edition you will read about the biosysnthesis of energetic ingredients—- microorganisms that serve as catalysts to perform steps in a reaction to produce products for the warfighter; the process of chemical scale-up—optimizing new Energetic Material for the warfighter; total asset visibility—providing the warfighter with real time inventory and environmental data; ATOS technology - successfully demonstrated in the field.

I am extremely proud of these most recent accomplishments and of our very unique and critical role within the Navy. I look forward to the coming year as an opportunity to further enhance our mission and fulfill our role as a premier Energetics Center. I am confident that with your enduring support and dedication we will continue to improve and accomplish our mission in the years to come.



We ensure operational readiness of the United States and allied forces by providing technical capabilities necessary to rapidly move any "energetics" product from concept through production, to operational deployment. Our capabilities include: research, development, testing, and engineering; acquisition; manufacturing technology; manufacturing; industrial base, fleet, and operational support for warheads; explosives; propellants; pyrotechnics; energetic chemicals; rocket, missile, and gun propulsion systems; missile simulators, trainers, and test and diagnostic equipment; tri-service cartridge-actuated devices, propellant-actuated devices, and aircrew escape propulsion systems; and other ordnance products.

Our capabilities provide technical expertise for special weapons, explosive safety, and ordnance environmental support. These technical capabilities and this expertise support all Naval warfare areas as well as the Army, Air Force, and private sector.



The Biosynthesis of Energetic Ingredients

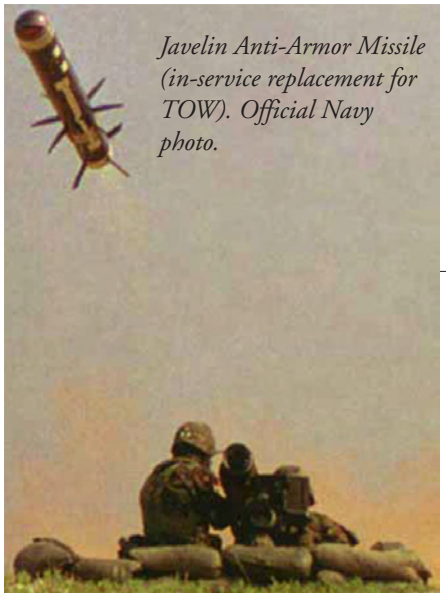
by Randall J. Cramer
Applied Technology Department

No one is considered too small to be part of the Indian Head team—including microorganisms that make explosives and their ingredients—when it comes to supporting the Warfighter.

Microorganisms can serve as catalysts in reactions to produce the products that we desire. A common example is the use of yeast to convert corn sugars into alcohol. In a similar fashion, genetically engineered strains of bacteria can convert other sugars into alcohols like 1,2,4-butanetriol, the precursor to one of Indian Head Division's manufactured chemicals 1,2,4-butanetrioltrinitrate (BTTN).

BTTN, an energetic plasticizer with properties that make it attractive as a useful replacement for nitroglycerine (NG) in double base propellants and other energetic formulations, enjoys fielded use in Hellfire and Javelin missile systems. However, the current 1,2,4-butanetriol industrial chemical manufacturing process uses petroleum based starting materials and makes BTTN more expensive than NG. The high cost of BTTN has been the main reason

An SH-60B "Sea Hawk" assigned to Light Helicopter Anti-Submarine Squadron Four Six (HSL-46) from Mayport, FL fires a AGM-114 "Hellfire" missile during Composite Training Unit Exercise (COMPTUEX). IHDIV manufactured chemical, BTTN, is used in double-based propellants found in the Hellfire missile system. Official U.S. Navy Photo.



Javelin Anti-Armor Missile (in-service replacement for TOW). Official Navy photo.

Bacteria E. coli serve as catalysts to produce enegetic ingredients.

for the limited number of orders Indian Head Division has had to manufacture, as well as the lack of qualified new propellants containing BTTN. The biosynthesis pathway, on the other hand, where *E. coli* converts pentose sugars into 1,2,4-butanetriol, may change all that.

Biosynthesis is a fermentation process not unlike that of brewing beer. The reactions are performed in warm water, and the energy requirements and environmental impacts are low. The bacteria make the desired products from renewable biological sources, not from expensive nonrenewable petroleum products. "This is truly a green chemistry," says Dr. Harold Bright at the Office of Naval Research (ONR), sponsor of the Green Synthesis Program. "Energetic ingredients cannot be made based on the renewable resources via photsynthesis." This gets us one more step away from dependence upon oil.

Although biotechnology and fermentation processes are new to the Applied Technology Directorate, the New Chemicals Scale-up Facility, in a strategy to prepare for the future, is adapting to the new biosynthesis processes. After working side-by-side with Professor John Frost, the scientific leader of ONR's Green Synthesis Program without whose seminal discoveries, ideas and talented graduate studies the program would never have succeeded, and the biotechnologists at Michigan State University (MSU), the Indian Head Division now has the staff and the fundamental knowledge to perform these new techniques.

"Working with MSU has given me the ability and understanding to perform basic fermentations and important analytical procedures like protein and enzyme analyses and optical density measurements," says Ordnance Department chemical engineer Shilpa Lad after completing a four-month detail at the university.

Another biosynthesized product is 1,3,5-trihydroxybenzene or phloroglucinol, the precursor to TATB, an insensitive explosive used in bomb fuze boosters. Here again, the starting material phloroglucinol is expensive and limited in availability but can now be biosynthesized from glucose using microorgansims.

The inventory of what our little *E. coli* friends are capable of producing is always increasing. For example, pure cellulose synthesized by *Acetobacter* strains is proposed for making pure nitrocellulose to improve gun performance and reliability. In addition, aliphatic nitro compounds, other nitrated products, and other high nitrogen compounds are also candidates under investigation.

As IHDIV experts and facility upgrades are aligned with biotechnology, evaluating and transitioning biosynthesized products into military use will continue to be handled by the Applied Technology Directorate. IHDIV will soon be receiving its first shipment of biosynthesized 1,2,4-butaetriol for evaluation. Teaming with academia, industry, the Office of Naval Research—and single-cell bacteria—this new technology promises huge future benefits to the U.S. military. For further information on this technology, contact Dr. Randall Cramer, 301-744-2578

Optimizing New Energetic Material for the Warfighter

The Evolution of Energetic Scale-Up

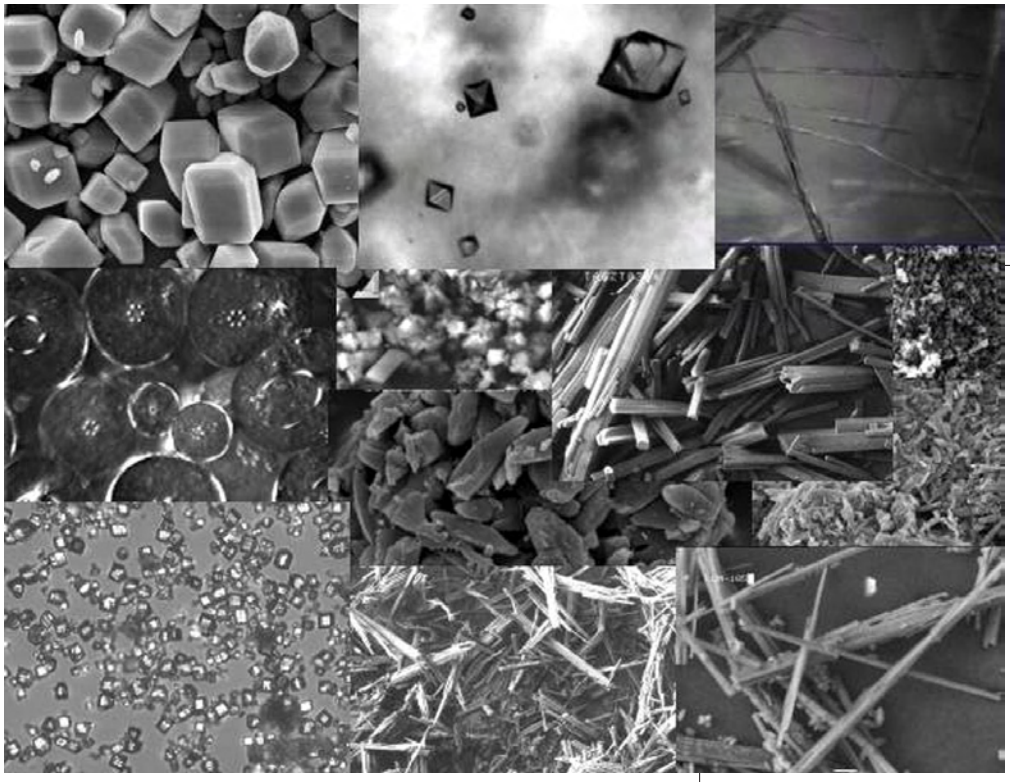
by Jerry Salan
Ordnance Department

Picture the old cartoons of the mad scientist in the laboratory focusing on test tubes overflowing with boiling solutions. The scientist usually adds a 'drop of this' and a 'pinch of that' until you hear a big boom as the scientist walks out of the laboratory in a puff of smoke, his hair standing straight in the air. Do you think that this scientist thought of completing a hazards analysis or conducting a peer review? If that scientist only knew the consequences of his actions, he may have tried a different reactant, a lower concentration, or a better process for mixing.

Over the last several years, the Indian Head Division (IHDIV) Chemical Development Branch of the Ordnance Department, has made significant progress in the evolution of new energetic material scale-up through equipment upgrades, process evaluations, and process improvements. The Chemical Development Branch performs numerous functions in the scale-up process including modeling, experimental design, optimization, and final scale-up. The advancements in technology and equipment provide the operator the proper controls to conduct the job in a safe manner. It should be noted that these improvements are built on the vast experience and knowledge that have been acquired over the years by past and present IHDIV employees.

Prior to this recent evolution, operators performed many steps using a hands-on approach, requiring operators to conduct the majority of operations standing near the reactor to initiate heating or cooling of the reaction mixture, adding ingredients to the reactor manually, draining the reactor manually, and isolating sensitive

The control room allows for a safer work environment to perform energetic material scale-up.



Energetic materials come in all shapes and sizes. Scale-up allows you to find the right material for the job.

products on filters. This approach exposed the operators to the process at hand and potentially an unsafe situation.

The most significant improvement in the evolution of scale-up is the ability to perform the majority of operations from a control room with a state-of-the-art programmable control logic system. The control room, a separate room beside the operating bays, allows the operator to perform 90 percent of scale-up procedures electronically as well as monitor processes remotely, removing the operator from a potentially hazardous environment. The control room also includes several cameras and an intercom system allowing the operator to see and hear what is happening in the operating bay.

This evolution also includes the utilization of emerging technologies and experimental design methods. In the past, operators did their best to manage with existing tools and often attempted optimization using the 'one at a time method of experimentation' or changing things one at time with no end in sight. Using the experimental design method you can actually change all the factors at once and determine how it affects your response.

The process of scale-up involves a series of experiments producing products at increasing quantities. The team begins by conducting a hazard analysis and a peer review. Various "What if…?" questions are addressed by reviewing past experiences, modeling, and by conducting numerous experiments.

The following are examples of challenges during the scale-up process (the names of the compounds have been removed to protect the innocent). In a simplified reaction such as the dilution of acid, "What if… you planned to add a concentrated acid to water?" During a peer review you may be asked questions such as, "How quickly do you plan to add the acid to the water? What cooling fluid temperature will you use? What is the expected temperature rise? What happens if you lose cooling?"

Some will argue that you could simply run the experiment in the laboratory and get a feel for whether the reaction releases energy (exothermic) or absorbs energy (endothermic). Although many have had success in scaling without the use of calorimetry (measurement of heat flow), it is an absolute necessity when dealing with new reactions and working with energetic reactions.

We are simply solving the equation Q = U (A ((T (Tj); where Q = heat of reaction, U = overall heat transfer coefficient, A = available heat transfer area, Tr = reactor temperature, and Tj = jacket temperature. All of these variables are tightly controlled using a reaction calorimeter.

Chemical Development Branch
Front row. R to l. Shilpa Lad, Claire Wells, Shannon Lenahan, Ledru Swann.
Back row. R to l. Jerry Salan, Kim Hanson, Bob Farncomb, Pat Skahan, Chris Radack.

Remember those questions we talked about coming up at the peer review? By conducting one reaction we answered all the questions. This valuable information can now be used for all future scale-ups as long as the same reaction is involved.

Now that the energy balance is completed, a few more questions need to be asked related to this materials properties. One area of focus is crystallization, a hot topic that has been studied for years. "During crystallization what influences particle size? What influences your particle size distribution? Can you switch solvents without affecting purity or yield?"

The increasingly strong demand for control of specified size distribution, particle shape, filterability, processing, and purity have driven the need for better evaluation of crystallization techniques. One challenge faced daily with new energetic materials is deciding if a new material should be considered for future applications, based on its sensitivity and thermal stability. Particle shape, mean size, and purity most likely influence sensitivity and thermal stability. Crystallization, unlike size reduction techniques, allows these precious crystals to grow free of stress with a well-defined crystalline shape and morphology. So what is in our toolbox for crystallization?

There are many factors that influence crystallization of materials. The trick is to find the most significant factors that influence the desired response and evaluate these factors in-depth. Again, the experimental design method process quickly screens factors of interest in evaluating the responses, such as particle size, distribution, material sensitivity to impact, thermal stability, yield, cost, and more. The tools selected to aid in this process include the focused beam reflectance measurement (FBRM), particle vision and measurement (PVM), and ReactIR sensors.

The FBRM counts particles, providing the user with particle size, shape, distribution, and many statistical methods of evaluating data, providing the user with real-time data. The PVM, a camera that sits in your reaction mixture allowing real-time product review, is a great verification tool for the FBRM.

The ReactIR is our "eye in the reaction," revealing what compounds are in the solution. Using these tools in parallel provides user information on particle size, distrbution, reaction extent and formulation of potentially harmful byproducts. These three tools are used in an automated laboratory reactor (ALR) and provide the user with information to make decisions on scaling materials of interest.

Wow! Now you have a viable chemical reaction and data to share with your customer on the potential for increasing the material and the ability to change crystal distribution and morphology.

The next step is to make quantities of the material while still controlling quality of your product. Remember, you made your materials in a 1-L flask and you have identified the scaling factors. The scaling factors are critical to making sure there are no changes as you progress from the 1-L flask to a 1000-L reactor.

"How will you monitor any changes that may occur while you scale-up?" With years of experience and a lot of experiments under our belt, IHDIV experts have a solution—vessels of various sizes (up to 2000 L) that accept new sensors allowing changes to be monitored during scale-up. Keep in mind there are so many factors that could change during scale-up. For example, as you scale-up from a 1-L to a 1000-L vessel the mixing characteristics of the system will change. This could create 'dead zones', or pockets of unmixed solution/slurry. The well-mixed solution that was so valuable to us at the smaller scale could turn into a solution with localized heating and concentration gradients.

How do you deal with these types of problems? Glad you asked. It's time to introduce additional tools. Once a scaling effect is identified, the engineer must determine methods for mitigating the effect through engineering controls. For example, the reaction may be highly dependent on a well-mixed solution (homogeneous). If the mixture is not homogeneous a very sensitive by-product is formed that in turn sensitizes the product. After modeling the reaction in the desired reactor, we find that by changing the impeller (mixing device) and adding a baffle (provides additional agitation) a homogeneous mixture is achieved. The use of engineering controls seems to mitigate the detrimental effect.

IHDIV's expertise in scale-up includes optimizing energetic material for Advanced Gun Propellants used in the Mk 45, 5 inch, 54 caliber gun similar to the one seen here aboard the USS Curtis Wilbur. Official U.S. Navy Photo.

The next step is validating the final model in the plant. The scenario (including our model) is discussed in a peer review process and once everyone is in agreement with the solution, impellers are swapped and the baffle is added. The reaction is run again using real time analytical tools, the homogeneous mixture is achieved, and the product is ready for the customer. Job well done!

This is a great time to be a chemical engineer at IHDIV. The dynamic nature of our business allows us to tap into state-of-the-art technology on a daily basis, allowing operators to continuously scale-up new energetic materials in a safe and healthy manner, providing outstanding and reliable energetic formulations to the warfighter.

The mad scientist approach may be adequate when you are trying to find the optimal amount of food coloring for celery; however, explosive synthesis and scale-up require a drastic deviation from the mad scientist's long-standing approach and failures. How do we safely scale-up energetic materials? I don't have all the answers yet, but we are headed in the right direction. For more information contact Jerry Salan, 301-744-6123.

Advanced Technology Ordnance Surveillance - An Opportunity and a Solution

IHDIV/NSWC Expertise Advances System for the Warfighter

by Melissa Miller
Technology Development Department

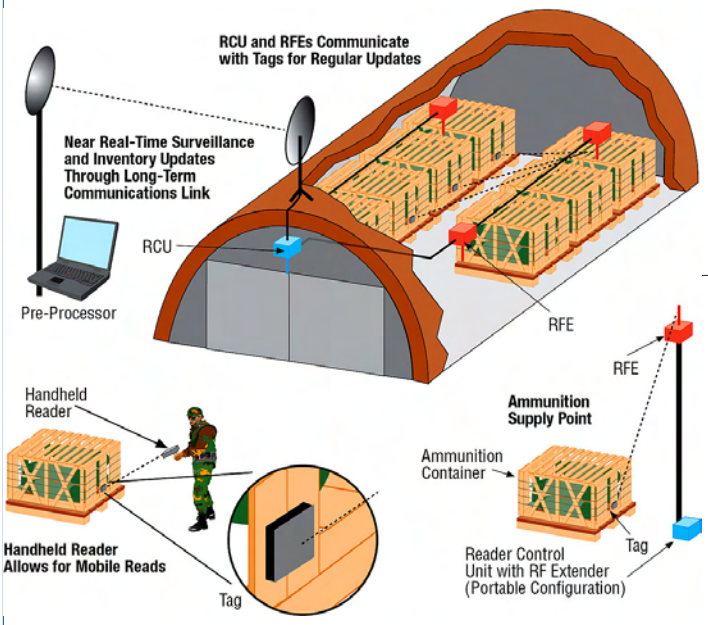
In today's military and logistics environment, the need for real-time, accurate, and automated total asset visibility (TAV) of ordnance and munitions is critical. Knowing and capturing three critical components—what is on hand, its exact location, and what conditions it has experienced—has the potential to save the military community countless hours and millions of dollars.

Within the Department of Defense (DOD) various types of automated identification technology (AIT) are currently being used to provide accurate and automated asset visibility. Complete and true asset visibility, however, is three-dimensional: establishing the asset's identity, location, and condition. The current AIT methods can provide identity and location of the assets, but lack the capturing of the third critical component—asset condition.

The Navy's Advanced Technology Ordnance Surveillance (ATOS) system, led and developed by the Indian Head Division, Naval Surface Warfare Center (IHDIV/NSWC), is a technology that will remove this roadblock. Not only does this system enhance and facilitate data capture, it serves as an enabler to improve the functional and business processes of an automated information system (AIS) and provides for all aspects of asset visibility including condition—the technical objective of the ATOS project. Today's warfighter needs to know that the mission-related ordnance put into their hands will perform as designed, safely and reliably.

ATOS tags located on weapon shipping containers will provide the warfighter accurate and real-time asset visibility.

ATOS
ATOS
ATOS
ATOS
ATOS
ATOS
ATOS
ATOS
ATOS
ATOS
ATOS
ATOS



The concept of ATOS operations.

The Importance of Environmental Surveillance

It is well known that everything ages over time and ordnance is no exception. By design, the average life of an ordnance item is 5 to 8 years. However, many program advancements have extended the service life of ordnance items to a point where the average in-service age of an item in the ordnance stockpile is approximately 25 years. As ordnance items age, they undergo chemical and physical changes, which affect the items' safety, reliability, and performance. Environmental stressors, such as temperature, humidity, and shock, accelerate this aging process and increase the ordnance's vulnerability to adverse stimuli. Therefore, it is very important to know the environmental extremes an item has experienced.

The military logistics environment can be a combination of extreme temperatures, as well as poor handling and storage conditions. For example, during Operation Iraqi Freedom, an incident occurred where one container in a shipment of eight Patriot missile containers was dropped. As the container had no visible damage, there was no way to determine which of the containers suffered the impact. Because of the possibility of damage to the solid grain propellants, guidance components, or both, all 8 containers (32 Patriot missiles) were sent back to the United States for evaluation and repair, incurring a total cost of over $21.9 million. This is just one example of how extreme environmental events can impact a program's budget and the military's mission readiness.

ATOS Background and System Description

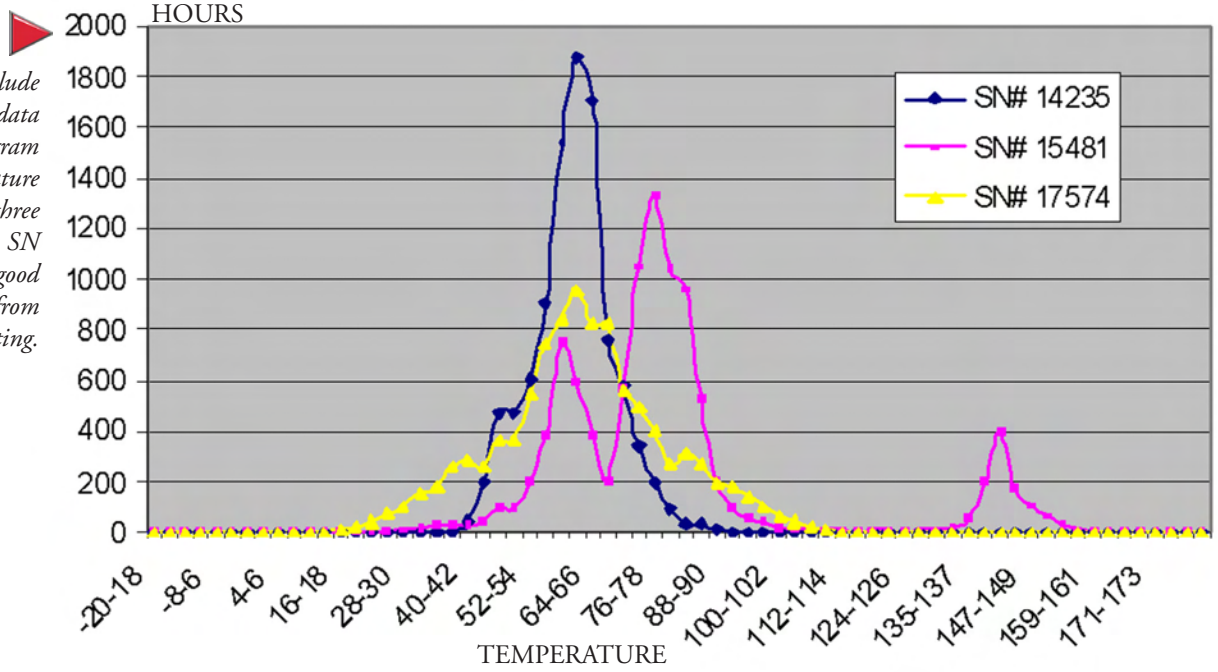
The Advanced Technology Ordnance Surveillance (ATOS) project is an Office of the Secretary of Defense (OSD) Advanced Concpet Technology Demonstsration (ACTD) initiatiave sponsored by the United States European Command (EUCOM) and led by the Deparatment of Navy (i.e., the Naval Sea Systems Command (NAVSEA), IHDIV/NSWC with joint support from the U.S. Army Materiel Command (AMC), U.S. Army Field Support Command and Joint Munitions Command (AFSC/JMC), U.S. Marine Forces, Atlantic (MARFORLANT), and U.S. Navy Commander Atlantic Fleet (CINCLANTFLT).

Designed to provide the ordnance manager, and ultimately the warfighter, with TAV on Class V assets (ammunition), ATOS is accomplished by combining modified COTS radio frequency identification (RFID) and sensor technologies, improving the safety and reliability of ordnance stockpiles, as well as providing better accuracy, efficiency, and cost avoidance for inventory management.

The ATOS system consists of four components:

- Handheld reader (HHR)
- Reader control unit (RCU)
- Radio frequency extender (RFE)
- RFID tags

The basic ATOS system consists of HHR with tags and docking station. The tags, located on the outside of any container



ATOS benefits include capturing asset data such as this histogram showing temperature reading from three tagged items. SN 15481 would be a good candidate to pull from stockpile for QE testing.

or item, collect the necessary asset and environmental exposure information, which is then uploaded to the inventory and environmental systems selected by the customer. The fixed reader system, consisting of a RCU with RFEs to extend coverage in large storage areas, provides the added benefits of automated and remote inventory management and environmental monitoring. In addition, ATOS also has the capability to store all asset and environmental surveillance data for a total of 13.1 years.

Lack of permanent power source or network connectivity, a typical environment in battlefield distribution sites, does not prevent the use of the fixed reader system. An external 24-V direct current source will power the unit and download inventory onto the handheld reader, allowing ATOS to be used in harsh environments.

ATOS has three main functions: automated identification, automated inventory management, and automated sensor data collection. For automated identification, ATOS uses active data-rich tags that contain all of the data elements common and unique to all of the service Ammunition Information Systems. This allows for the full automation of Military Standard Requisition and Issue Procedures (MILSTRIP) and Military Standard Transaction Reporting and Accounting Procedures (MILSTRAP) transaction feeds. The data on these tags can also be changed remotely an unlimited number of times, eliminating manual updates.

For automated inventory management, ATOS allows a commodity manager to search stockpiles worldwide by quantity and location, either remotely or on-site with a handheld reader. The ATOS tags contain four sensor ports that can be configured for any customer's application. Collected every hour, sensor readings are stored in both histo-

ATOS Benefits

- Improve ordnance readiness through surveillance.
- Improve overall ordnance stockpile management and logistics.
- Enable commodity managers to prioritize use of stockpiles at the smaller pallet level versus. larger lot level.
- Provide data quantity and quality needed to improve predictive and statistical models, refinement of test sample identification, environmental alarms for conditions or events, insight for engineering investigations, and improvement in future munitions designs.
- Provide commodity managers with a range of technical solutions for managing limited shelf life and environmentally sensitive materials.

Typical open storage area found during operational deployment. IHDIV's ATOS system will be able to save time and money in tracking asset identity, location, and condition.

gram and serial data formats. The histogram data is recorded in a 2-Kb file collected automatically whenever a handheld transaction is performed (issue, receive, transfer, partial issues, etc.). This data, when graphically represented, can provide a means to quickly prioritize the use of ordnance. Serial data is also collected, but not transmitted automatically because of its potentially large size.

This environmental data collected allows commodity managers to prioritize the use of stockpiles and provides the quality evaluation (QE) personnel a means to enhance predictive and statistical modeling, refine test sample selections, increase insight during engineering investigations, and improve future missile designs.

Successful Field Demonstrations

In FY04, ATOS successfully completed field demonstrations or Military Utility Assessments (MUAs) at Crane Army Ammunition Activity (AAA) in Crane, IN; Miesau Army Ammunition Depot, Germany; and aboard two Navy ships. An air shipment from the Crane AAA to the Norfolk Naval piers was also performed. At each site, the use of the ATOS system was successfully demonstrated for improving asset visibility, monitoring environmental exposure, and collecting environmental exposure data for ordnance items. The MUA technical and operational maturity ratings are at 73 and 80 percent,respectively, with users stating, "ATOS system is a great system. It would benefit the military and I hope to see it used in the future."

ATOS Benefits Other Applications

Designed primarily for ordnance, the flexible design of ATOS allows any commodity that experiences degradation in quality and shelf life due to age and environmental exposure, the potential to realize its benefits. Over the past year, ATOS has completed pilot demonstrations in various commodities such as personal protective equipment, life rafts, and medi

This earth-covered magazine at the Miesau Army Ammunition Depot, Germany provided the OCONUS demonstration a distinct environment to test the ATOS system.

A tractor moves a quadcon container at Kin Red Port in Okinawa. Quadcons are modular, lightweight and durable containers to be used for storage and transportation of equipment and supplies during deployment and in garrison. Transportation and storage containers such as these are potential future environments for IHDIV's ATOS. Official U.S. Marine Corps photo.

cal International Standardization Organization (ISO) shelter surveillance. Results from these demonstrations will be used to improve predictive models for their respective commodities. In FY07, ATOS will also be used in a pilot to detect toxic industrial chemicals.

The Future of ATOS

The ultimate goal of any QE program is advanced knowledge of inventory issues and a corrective action plan for specific tagged assets known to have experienced an extreme environmental event—ATOS can help to make this a reality. ATOS will continue to work with other QE programs to push for the development of advanced sensors, batteries, enhanced external sensor ports, and a reduced footprint. Other plans include working with programs to embed the RFID devices or tags within the ordnance itself.

ATOS will continuously evolve to ensure operational support, paying particular attention to reducing the logistics footprint; implementing human factor sensitive features; improving ammunition inventory management system integration; designing for tag production and extension of tag service life; ensuring the most affordable and protected critical program information on munitions stockpiles and environmental records; and demonstrating superior system integration, interoperability, safety, and utility.

The Navy has invested in developing not only a unique RFID sensor system, but also developing a team of RFID and sensor experts at IHDIV. This team is skilled not only in tailoring the technology and tools to suit the customer's application, but also ensuring all certifications, approvals, and specifications are met and business processes enhanced for each application. It is this combination of technology and expertise that is crucial to providing the Navy with leading technology and applications to reduce the cost and effort associated with inventory and shelf-life management of supplies and equipment across all commodity groups.

If you would like more information on ATOS, IHDIV capabilities in this area, or would like to see an operational magazine configuration, please contact Melissa Miller, ATOS Program Manager, 301-744-4879 or melissa.o.miller@navy.mil. (see following article on ATOS successes, page 13).

ATOS Technology Successfully Demonstrated in the Field

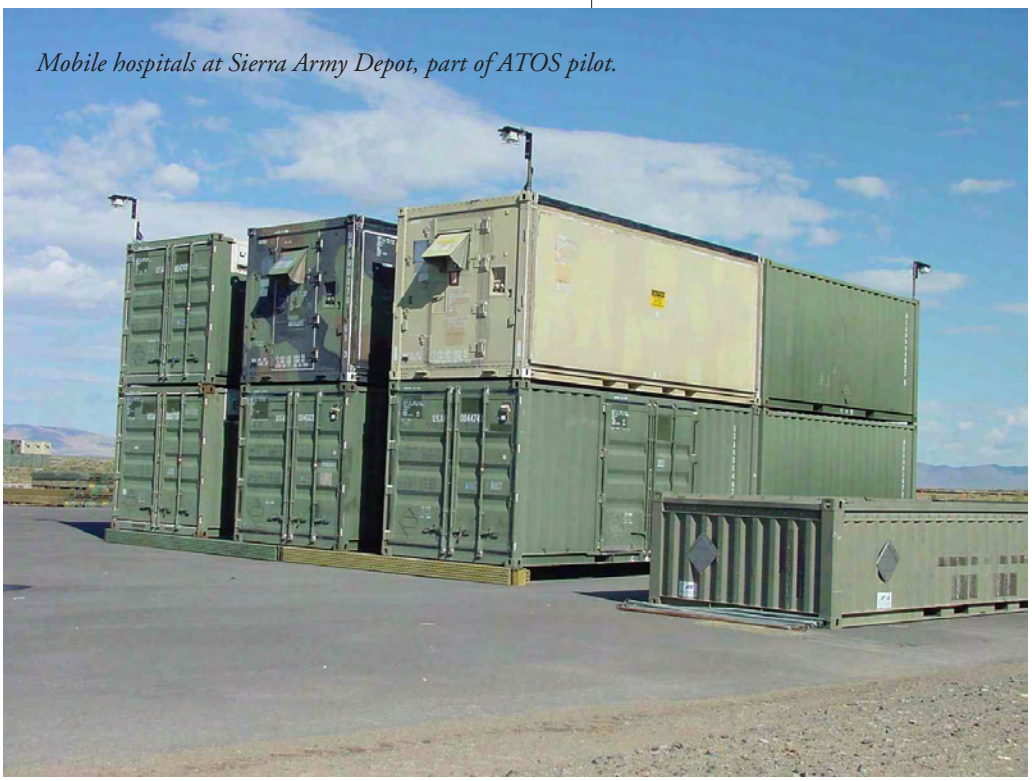
by Mike W. Dunn
EHS Technolgy
& Melissa Miller
Technology Development
Department

The Indian Head Division (IHDIV) has successfully demonstrated its radio frequency identification/micro-electromechanical sensor (RFID/MEMS) technology to monitor Army medical equipment. This technology was developed during the Advance Technology Ordnance Surveillance (ATOS) Advance Concept Technology Demonstration (ACTD).

Although ATOS was designed primarily to provide the ordnance manager (and ultimately the warfighter) with total asset visibility on Class V assets (ordnance), its flexible design also has the capability to provide the warfighter with information on commodities that experience degradation in quality and shelf life because of age and environmental exposure. ATOS combines modified commercial off-the-shelf RFID and sensor technologies improving the safety and reliability of environmentally sensitive stockpiles, as well as providing better accuracy, efficiency, and cost avoidance for inventory management.

The system collects all the necessary data to automate all processes involved with asset accountability, to enhance visibility of tagged material (such as location, identification, and current condition), and to improve the future design of the tagged item.

Military logisticians have been looking to adapt this technology for other crucial DOD commodities. IHDIV was funded by the Army's Logistics Transformation Agency (LTA) to begin a pilot project to demonstrate the use of ATOS technology



Mobile hospitals at Sierra Army Depot, part of ATOS pilot.

Tag and Antenna mounted on medical storage container.

for monitoring medical materials stored in mobile hospitals. The Sierra Army Depot in Herlong, CA stores 60 mobile hospitals for the Army Reserve and was therefore an excellent location for the pilot.

Each mobile hospital is comprised of approximately 80 storage containers. These 1,280 cubic foot containers are stocked with operating tables, sutures, defibulators, x-ray film, surgical tubing, and a wide variety of other medical supplies and equipment needed for a fully operational Mobile Army Surgical Hospital (MASH) units. Much of the equipment is sensitive to degradation and damage from moisture or extreme temperature levels, and therefore must be monitored.

Currently, the Army visually inspects colorimetric humidity indicators on almost 3,000 containers. The data is subjective to the person reading the indicator, provides only approximate values, is only collected weekly, and does not include temperature monitoring. The Army tasked IHDIV with finding a more accurate, complete, and cost effective solution for monitoring the materials during storage.

In September 2005, IHDIV began operating a pilot-scale RFID/MEMS system at the Sierra Depot. This technology is set up to collect and report both temperature and humidity data on an hourly basis. The system generates automatic temperature and humidity profiles and histograms that can be accessed remotely by Army personnel worldwide via the internet. This web application also provides automatic e-mail alerts to the Army medical managers when pre-set temperature or humidity levels are exceeded.

The RFID-MEMS information has the potential to save the DOD a significant amount of money in several ways:

- It eliminates the need to drive around the Depot and visually inspect and record data on the containers.
- The data can be used immediately to identify leaking or damaged containers. Containers can be opened and equipment removed before it is compromised.
- Engineers will better understand how medical equipment reacts to and withstands temperature and humidity extremes and work with manufacturers to design improved materials and packaging, if necessary.

The ATOS system also provides the mobility to be used anywhere in the world. Readers can be readily set up "in-theater" and connected to a laptop via wireless networks. From there logisticians can monitor medical materials in the more extreme environmental locales where the hospitals are normally deployed such as the Middle East and South East Asia.

Although not utilized during this pilot project, perhaps the greatest potential RFID/MEMS holds is for monitoring the location and exact contents of the medical equipment containers. Logisticians can use this technology to reduce inventory costs and remotely identify the location of critical equipment (or even identify material shortages) needed to resupply the MASH unit.

This pilot project was initially scheduled to cover only three months. However, based on the successes of the utility of the data, the Army has asked IHDIV to extend the pilot through the summer of 2006 to capture data through all four seasons. IHDIV received additional funding in December 2005 to support transitioning the technology into a fielded system.

This pilot project is just another example of the enormous potential that IHDIV's ATOS technology has for cost savings in DOD logistics and commodity management. More importantly, it can help ensure that military doctors and nurses have the proper medical equipment and supplies to treat our wounded soldiers.

If you would like more information on ATOS please contact Melissa Miller, ATOS Program Manager, 301-744-4879 or via email at melissa.o.miller@navy.mil.

Indian Head Division
Naval Surface Warfare Center
101 Strauss Avenue
Indian Head, MD 20640-5035
www.ih.navy.mil